

Acquisition and Filtering of Relevant Driving Parameters of Electric Cars

Michael S. J. WALTER¹, Stefan WEIHERER¹, Tiffany HAAS¹, Dac L.DAO¹, Alexandru SOVER¹

¹University of Applied Sciences Ansbach, Residenzstr.8, 91522 Ansbach, Germany

Abstract – The increasing demand on alternatives to fossil-fuel-based mobility concepts goes hand in hand with a significant growth of research activities on electromobility. In consequence, an adequate data acquisition and preparation is highly required to quantify these research activities' benefits. However, currently available electric cars do hardly support an easy and reliable data acquisition. This paper presents a procedure to gain and monitor relevant driving parameters of an electric car (Renault ZOE R240). Therefore, a filter application is applied to the raw data, gained via the on-board-diagnosis-protocol. The practical use of the procedure is shown in two test drives with the Renault ZOE.

Keywords – *e-mobility, electric car, on-board-diagnosis (OBD), data acquisition, filtering of driving parameter*

I. INTRODUCTION

The increasing demand of politics on alternatives to fossil-fuel-based mobility concepts results in a significant growth of corresponding research activities. However, the quantification of these research activities' benefits depends essentially on the data gained in field tests and numerous experiments. Therefore, a procedure on how to acquire and monitor these relevant data is highly relevant to ensure objective and reliable research results.

Considering electric cars, current available models do hardly support an easy and reliable data acquisition [1, 2] - i.e. due to individual data protocols, security aspects as well as the car manufactures' regulations concerning secrecy. The paper's authors present a procedure to gain and monitor data of relevant driving parameters of an electric car (Renault ZOE) via the on-board-diagnosis interface as well as a filter application to extract and structure the relevant data from the car's on-board data-protocol.

The authors' contribution to the current state of the art is seen in the recommendation of a free and open-source based procedure on the acquisition and monitoring of relevant driving data. This procedure can be easily adapted to other vehicles that provide an adequate diagnosis interface. So the procedure will support an objective and reliable quantification of the vehicle's current status.

II. PROCEDURE

The procedure can be divided into three main steps – *pre-processing*, *processing* and *post-processing*. The comprehensive step-by-step procedure is shown in Fig. 1.

During the *pre-processing* an adequate Bluetooth connection has to be established between the car's on-board-diagnosis (OBD) interface and a device that provides access to the open-source app canZE [3].

The *processing* step includes the test drive as well as the entire monitoring activities of the driving data. The application canZE is able to receive information about driving parameters. However, the app stores those in an unstructured matter in raw-files (such as **.field*). By closing the app the monitoring process (as well as the storage of the gained data in the raw-files) is finished.

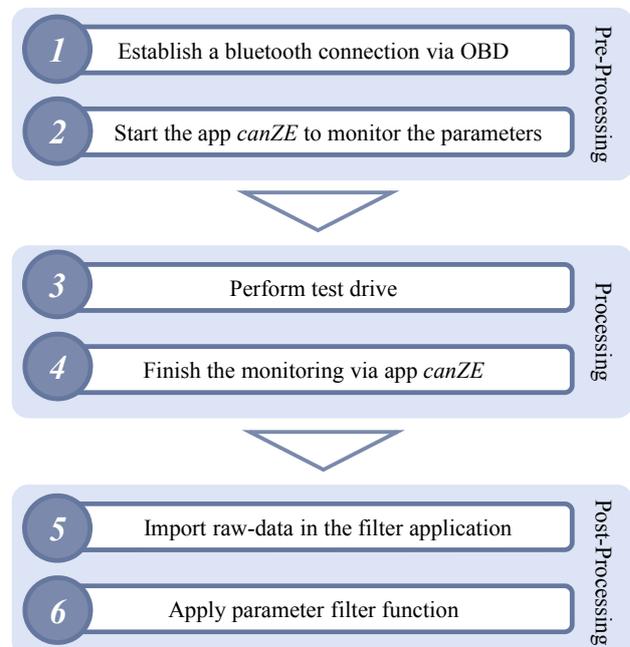


Fig. 1. Procedure to acquire structured data of relevant driving parameters of an electric car

To provide an adequate data-base for further analysis and visualization of driving parameters, a filter application is applied during *post-processing*. This

application extracts the corresponding information about a driving parameter in a structured manner by sorting the raw data in accordance with given parameter-IDs as well as the given time stamp. These parameter-IDs are previously defined by the car manufacturer's on-board-protocol and are not subject to change. A selection of some parameter-IDs according to [3] is given:

- State of charge of battery: 7ec.623206.24
- Velocity: 5d7.0
- Engine revolutions: 1f8.40
- Voltage of 12V battery: 7ec.622005.24

III. CASE STUDY: TWO TEST DRIVES

The practical application of the presented procedure is shown in a case study. Therefore, two test drives with the university's Renault ZOE R240 (see Fig. 2) were performed on July 20th 2017. The driving data were acquired according to the proposed procedure.



Fig. 2. Research vehicle "Renault ZOE"

A. Relevant facts on test drive #1

The relevant facts on the first test drive are:

- Date: July 20th 2017
- Time: 01.59:27^{pm} – 02.50:35^{pm} ($\approx 51,1$ min)
- Weather: partly clouded at 21 °C
- Route: University Ansbach to Heilsbronn and back
- Status of *ECO*-mode: on
- Status of climate control: off
- Load: 3 persons
- OBD Dongle: MaxiScan 902

B. Relevant facts on test drive #2

The relevant facts on the second test drive are:

- Date: July 20th 2017
- Time: 02.51:50^{pm} – 03.40:20^{pm} ($\approx 48,5$ min)
- Weather: clouded, light rain at 20 °C
- Route: University Ansbach to Heilsbronn and back
- Status of *ECO*-mode: off
- Status of climate control: on (temp: 21 °C)
- Load: 3 persons
- OBD Dongle: MaxiScan 902

During the test drives the relevant driving parameters are monitored by the app *canZE*. By means of the detailed procedure, we "extracted" each of those parameters during the test drives in structured form. Four selected parameters are detailed in the tables 1 and 2.

C. Route

Each test drive includes the drive from the University Ansbach (GPS 49.305516, 10.567302) to Heilsbronn (GPS 49.341250, 10.804032) and back. The driving distance between both destinations is 18.9 km. Hence, the total driving distance of a test drive sums up to 37.8 km. An elevation profile of the route is shown in Fig. 3.

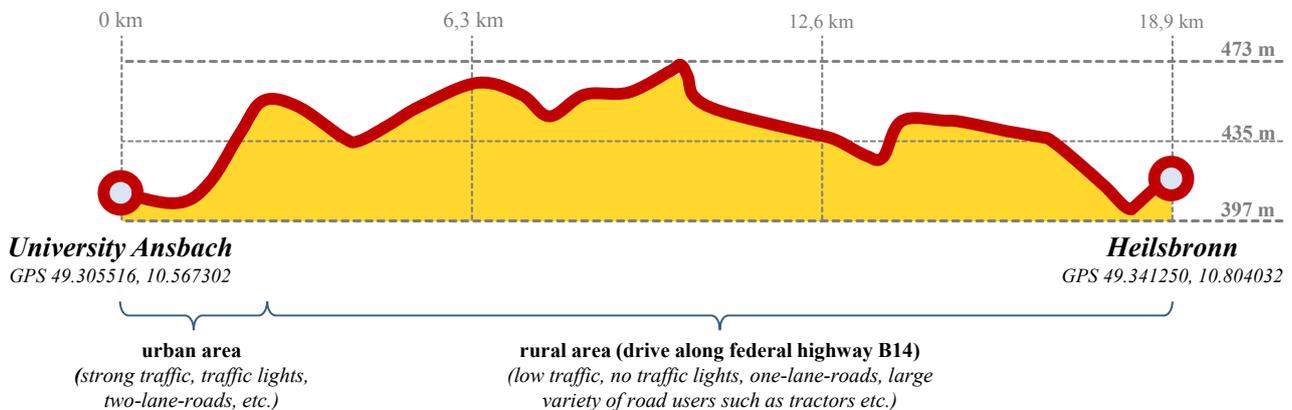
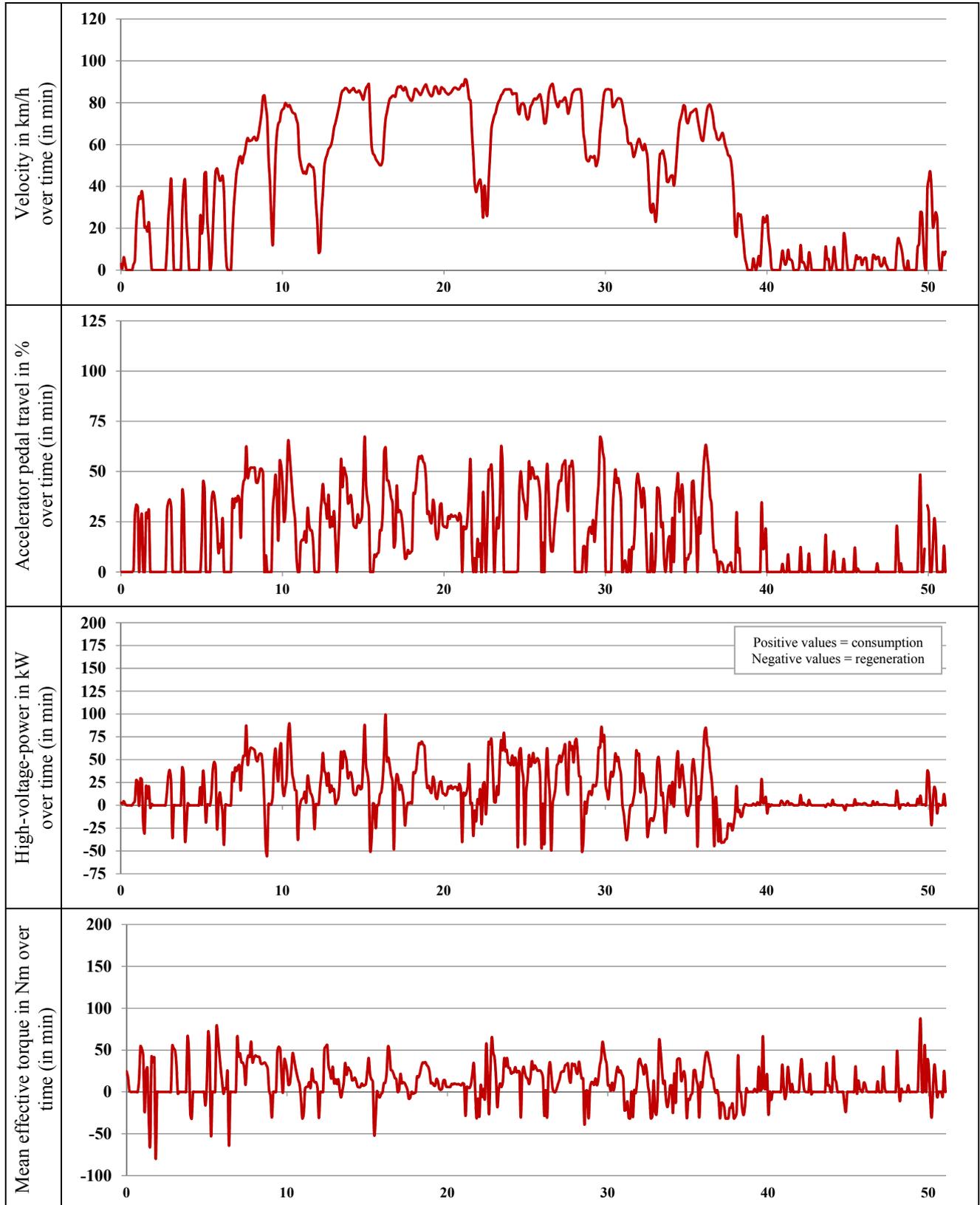


Fig. 3. Elevation profile of test route from University of Ansbach to Heilsbronn and back (elevation in meters above sea level)

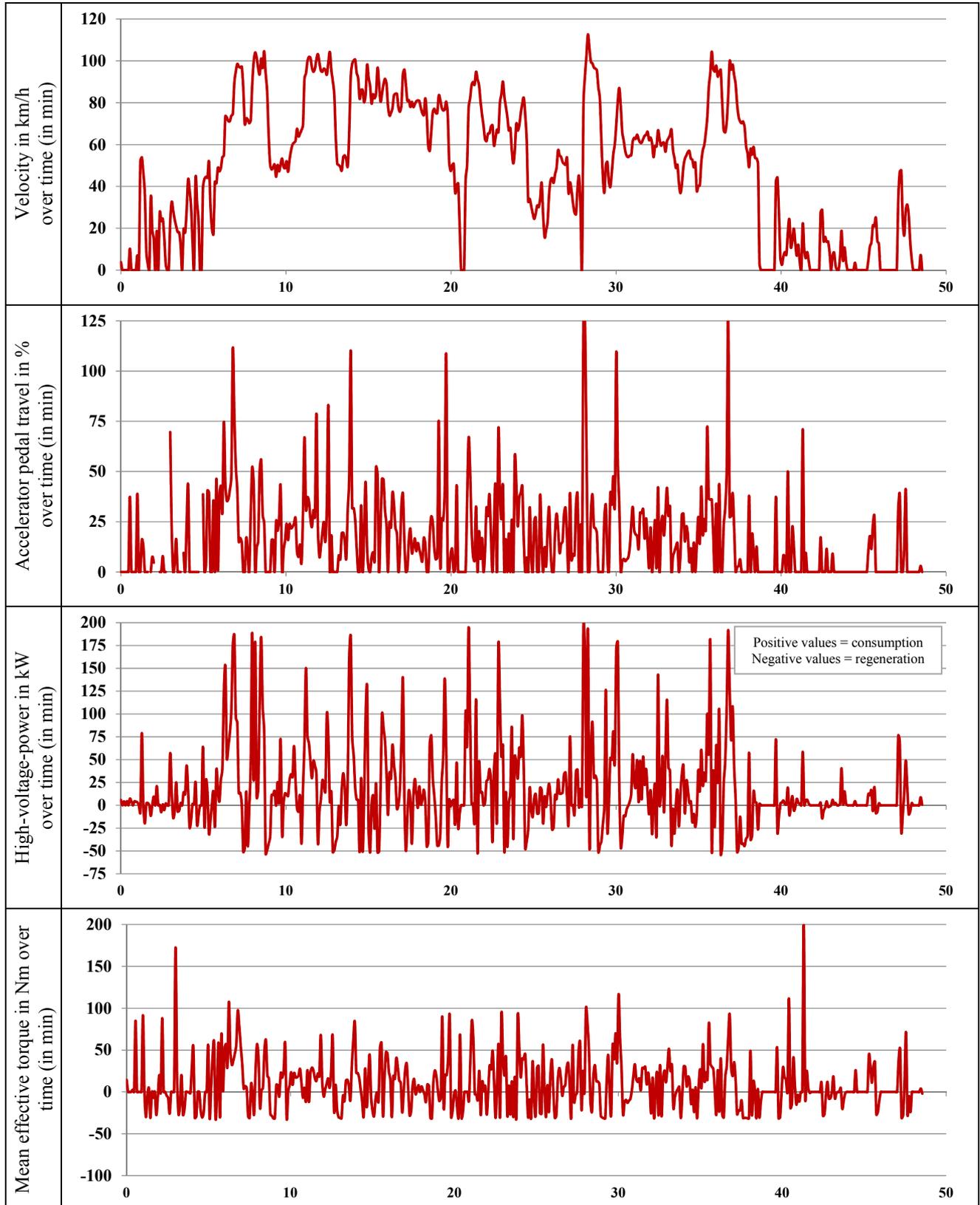
IV. RESULTS OF TEST DRIVE #1

Table 1. Selection of four time-dependent driving parameters



V. RESULTS OF TEST DRIVE #2

Table2. Selection of four time-dependent driving parameters



VI. QUASI-STATIC DRIVING PARAMETERS

In contrast to highly dynamic parameters (such as velocity and engine torque), several parameters do not change its values in quite short time intervals. These parameters are called quasi-static parameters. The following figures detail the quasi-static parameters *state-of-charge* (Fig.4), *milage* (Fig.5) as well as the estimated *remaining range* of the car (Fig.6).

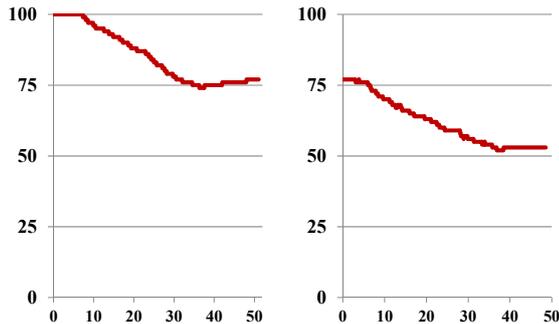


Fig. 4. State-of-charge in % of test drive #1 (left) and test drive #2 (right)

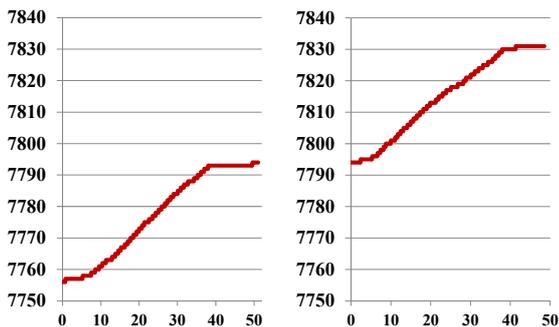


Fig. 5. Milage in km of test drive #1 (left) and test drive #2 (right)

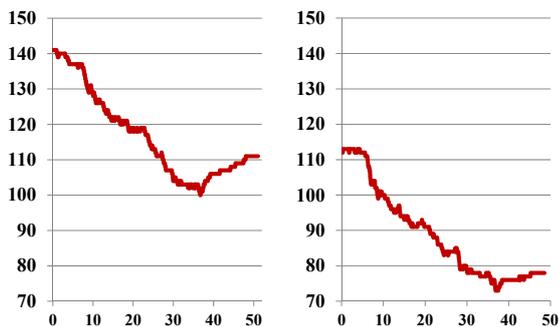


Fig. 6. Estimated remaining range in km of test drive #1 (left) and test drive #2 (right)

VII. SELECTED RESULTS

The data reveals great insights in the test drives. So it is obvious, that the first test drive was performed with a pro-active driving style, while the data of second test drive indicated strongly towards a sporty style of driving.

Another interesting fact is, that during the last ten to fifteen minutes of both test drives the velocity of the car was quite low – assuming stop-and-go traffic. This caused, since the elevation profile details an downhill drive during that sequence, recovery of brake energy (recuperation) for charging the battery. This can be seen in an increasing state-of-charge (e.g. test #1: from 74 % to 77 %; see Fig. 4) as well as in an – comparatively too strong – increase of the estimated remaining driving range (test drive #1: from 101 km to 111 km; see Fig. 6).

VIII. CONCLUSION

This paper presents an approach to gain and filter driving parameters of an electric car via the OBD-interface. The procedure may be helpful for engineers and researchers dealing with the analysis and optimization of electric cars, since the resulting parameters give in-depth insights both in the characteristic operation of the car as well as the driver behavior and driving circumstances.

However, several limitations are still seen. The procedure is not fully automated and thus not yet able to provide data in real-time. Furthermore, the statistical reliability of the data (and the on-board-computer-system) is currently not sufficient. A promising approach may be the implementation of artificial intelligence (such as artificial neural networks [4]) in the on-board-systems for e.g. a more realistic estimation of the remaining driving range. Finally, to increase comparability between several test scenarios (according to an adequate design of experiments), the development and application of a numerical test drive simulation [5] is recommended.

IX. ACKNOWLEDGMENT

The authors gratefully thank the **Biomass Institute Bavaria** for supporting the research project. Furthermore, our gratitude belongs to the minds behind the open-source App **canZE**, which was used in this work.

REFERENCES

- [1] Najah, A. A.; Mervat, A.; Salah, B.: *Utilizing VIN for improved vehicular sensing*. In: IEEE Wireless Communications and Networking Conference (WCNC), 2016, 3.-6.- April 2016.
- [2] Zhu, H.-Z.; Yang, X.-G.: *The acquisition and transmission of vehicle traveling information to use smartphone*. In: Proceedings of International Conference on Logistics Engineering, Management and Computer Science (LEMCS 2014), 24.-26. May 2014, Shenyang, pp. 897-902.
- [3] N.N.: canZE. URL: <http://canze.fisch.lu/>. Access on April 8th 2017.
- [4] Walter, M.; Sprügel, T.; Wartzack, S.: *Tolerance analysis of systems in motion taking into account interactions between deviations*. Journal of Engineering Manufacture, vol. 227, no. 5, pp. 709-719.
- [5] Walter, M.; Storch, M.; Wartzack, S.: *On uncertainties in simulations in engineering design: A statistical tolerance analysis application*. SIMULATION, vol. 90, no. 5, pp. 547-559.